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## Assessment of a high tackle on ball carrier inertial head kinematics in rugby union

Gregory J. Tierney, Ciaran K. Simms

### I. INTRODUCTION

The tackle height law in rugby union has been an area of concern for many years. It is currently set at the line of the ball carrier's shoulder. Tierney and Simms [1] previously demonstrated that tackling at the ball carrier's upper trunk accounts for nearly half of all tackler head impacts.

Before tackle height laws can be changed, it is essential to examine the biomechanics of tackling at the upper trunk on ball carrier inertial head kinematics. The goal of this study is to use Model-Based Image-Matching (MBIM) to examine the severity of a legal tackle to the upper trunk of the ball carrier (with no head contact).

### II. METHODS

Model-Based Image Matching (MBIM) is an approach that utilises multiple camera view video and a skeletal model to extract six degree of freedom head kinematics directly from video [2]. In this study, MBIM was used to measure the ball carrier's head kinematics during a real-world tackle to the upper trunk region (Fig. 1). Three synchronised camera views (25 fps) were available for the matching.

In this case, the ball carrier was passing the ball and appeared unaware of the impending tackle. The tackler contacted the ball carrier after the ball had been released. The tackle was considered legal as the tackler had committed to the challenge whilst the ball carrier had the ball in his hands.



Fig. 1. The MBIM technique applied to the ball carrier's head, for a given video frame, in a real-world tackle to the ball carrier's upper trunk region.

### III. INITIAL FINDINGS

Fig. 2 shows the componential head angular velocity values from this case.

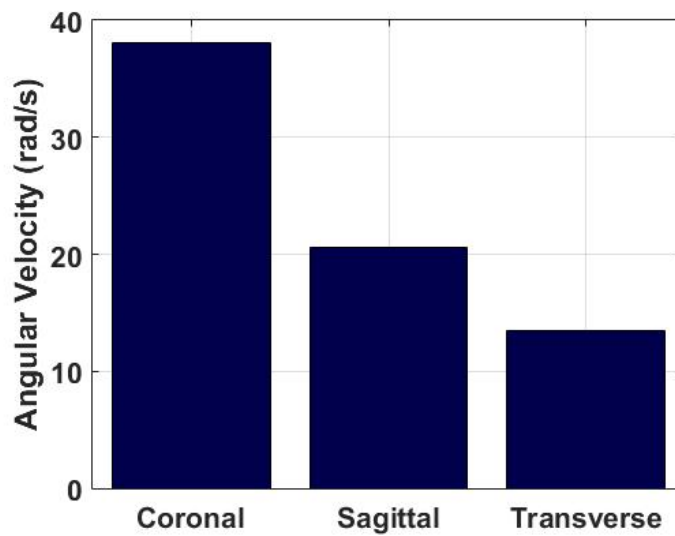


Fig. 2. The componential maximum change in head angular velocity results from this case.

### IV. DISCUSSION

As a result of the tackle, the ball carrier's head kinematics indicated a greater than 75% chance of sustaining a concussion, based on the literature [3]. This was the case even though no contact was made with the ball carrier's head. The potential to repeatedly engage in this type of legal tackle is a concern.

Previous studies, utilising staged tackles in a motion analysis laboratory and multibody modelling approaches [4], have shown that by lowering the tackle height law to below the upper trunk (chest), ball carrier inertial head kinematics can be reduced significantly. Potentially by over 50%. This in turn should reduce the repetitive loading placed on the brain. Future work will seek to identify suitable lower tackle cases for MBIM application.

### V. References

- [1] Tierney, G. J., Simms, C. K., *IRCOBI*, 2017.
- [2] Tierney, G. J., *et al.*, *Sports Biomech*, 2018.
- [3] McIntosh, A. S., *et al.*, *BMJ Open*, 2014.
- [4] Tierney, G. J., *et al.*, *J Biomech*, 2018.